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H4P PAQ

(56) Documents Cited
GB 2326038 A GB 2326037 A GB 2236225 A
EP 0782249 A1 WO 91/03882 A1 US 5826180 A
US 5678220 A

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INT CL[6] H03D 1/22 7/16 7/18 , H04B 1/26 1/30 , H04L 27/233 27/38
Online : EPODOC

(54) Abstract Title
Image rejection filters for quadrature radio receivers

(57) A quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the quadrature receiver having a digital image rejection filter 26 comprising processor means 18,19,20,21 arranged to impart to the quadrature and in-phase signal a substantially 90° shift to the negative frequencies and impart a substantially opposite 90° shift to the positive frequencies; and combining means 22,23 for combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative frequency components are substantially cancelled.

A second embodiment uses a band-pass filter in the image rejection filter.

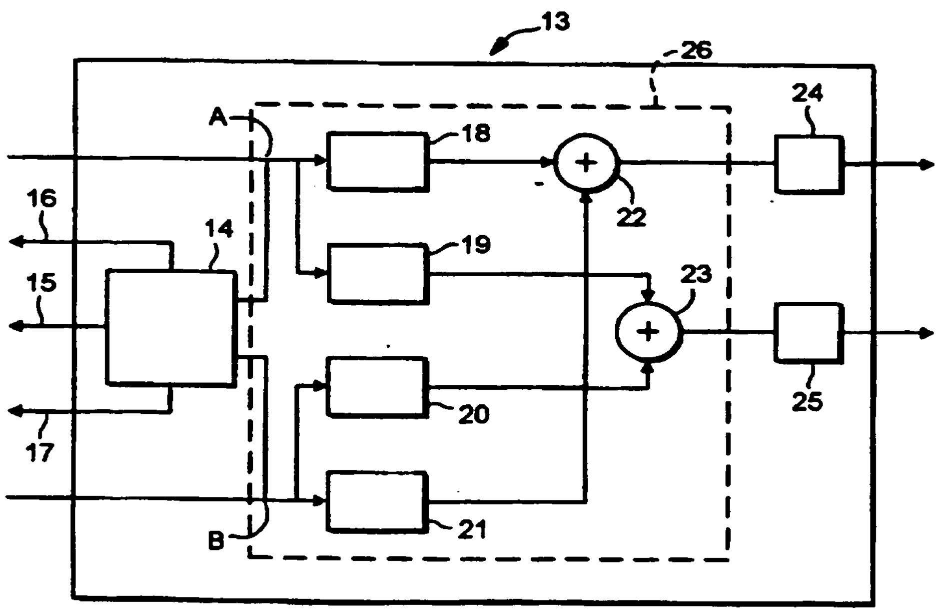

FIG. 3

GB 2 345 230 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

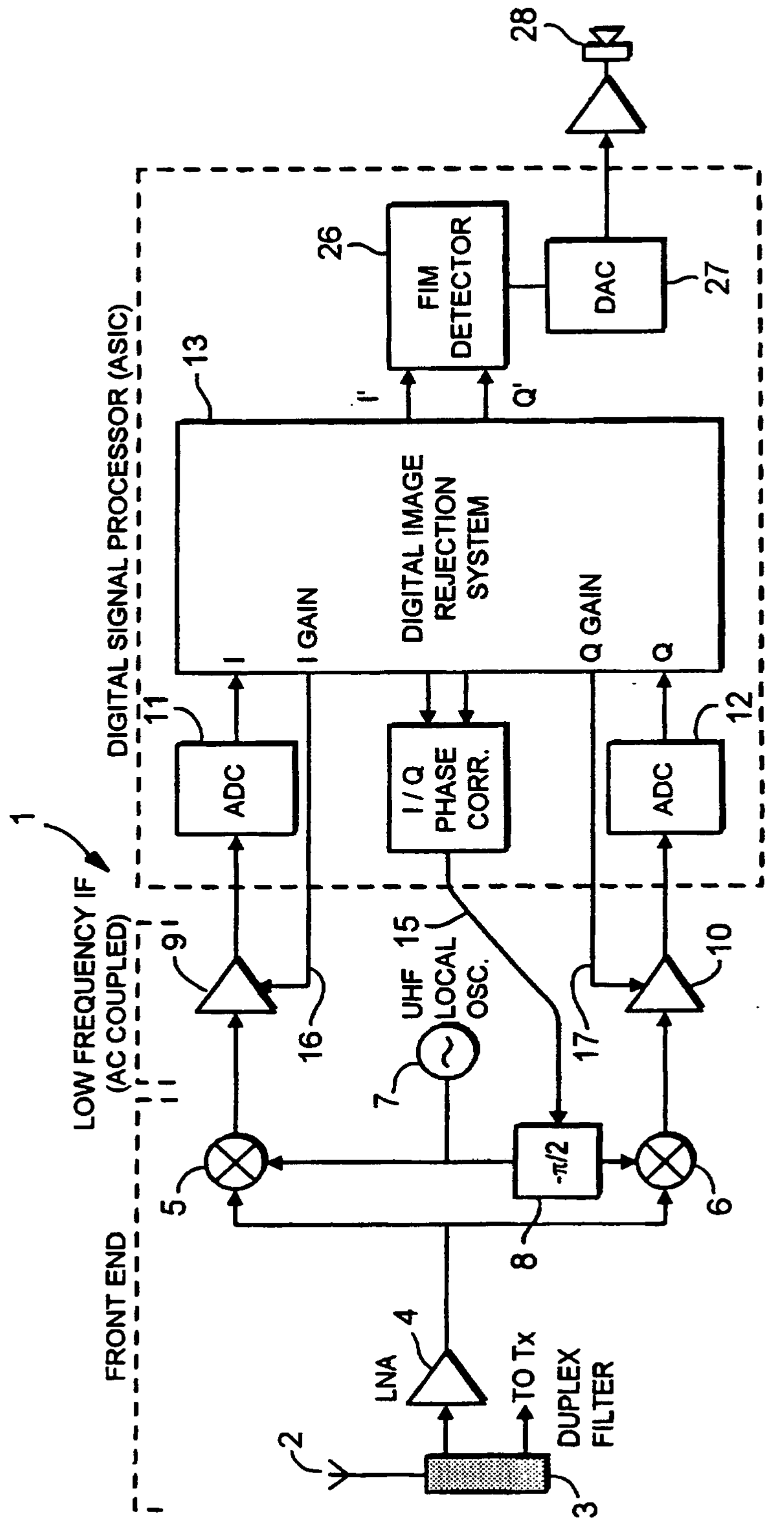
FRONT END
LOW FREQUENCY IF (AC COUPLED)
DIGITAL SIGNAL PROCESSOR (ASIC)
1
2
3
DUPLEX FILTER
TO Tx
LNA
4
5
6
8
-π/2
7
UHF LOCAL OSC.
15
9
10
16
17
ADC
11
ADC
12
I / Q PHASE CORR.
I
I GAIN
Q GAIN
Q
DIGITAL IMAGE REJECTION SYSTEM
13
I'
Q'
FIM DETECTOR
26
DAC
27
28

FIG. 1

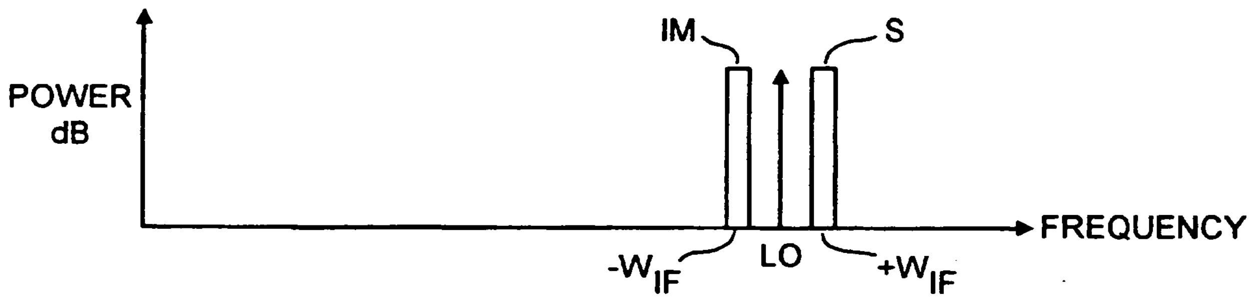

FIG. 2a

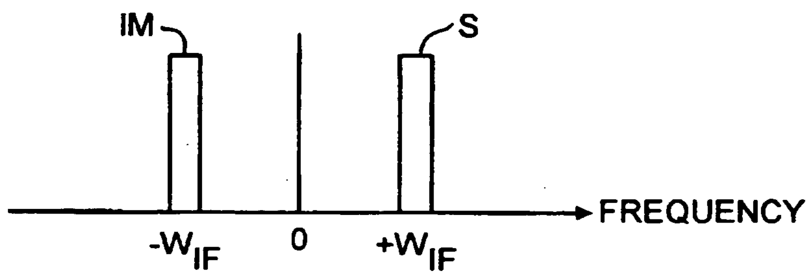

FIG. 2b

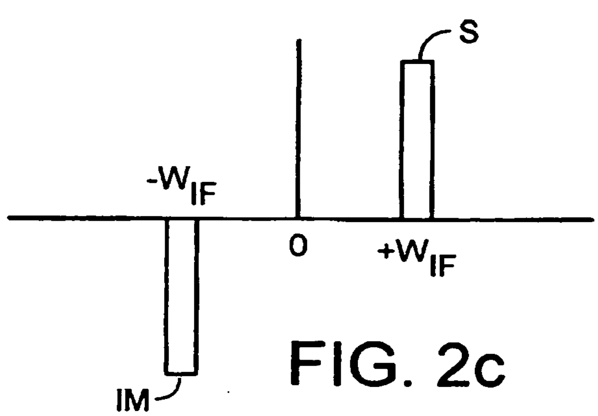

FIG. 2c

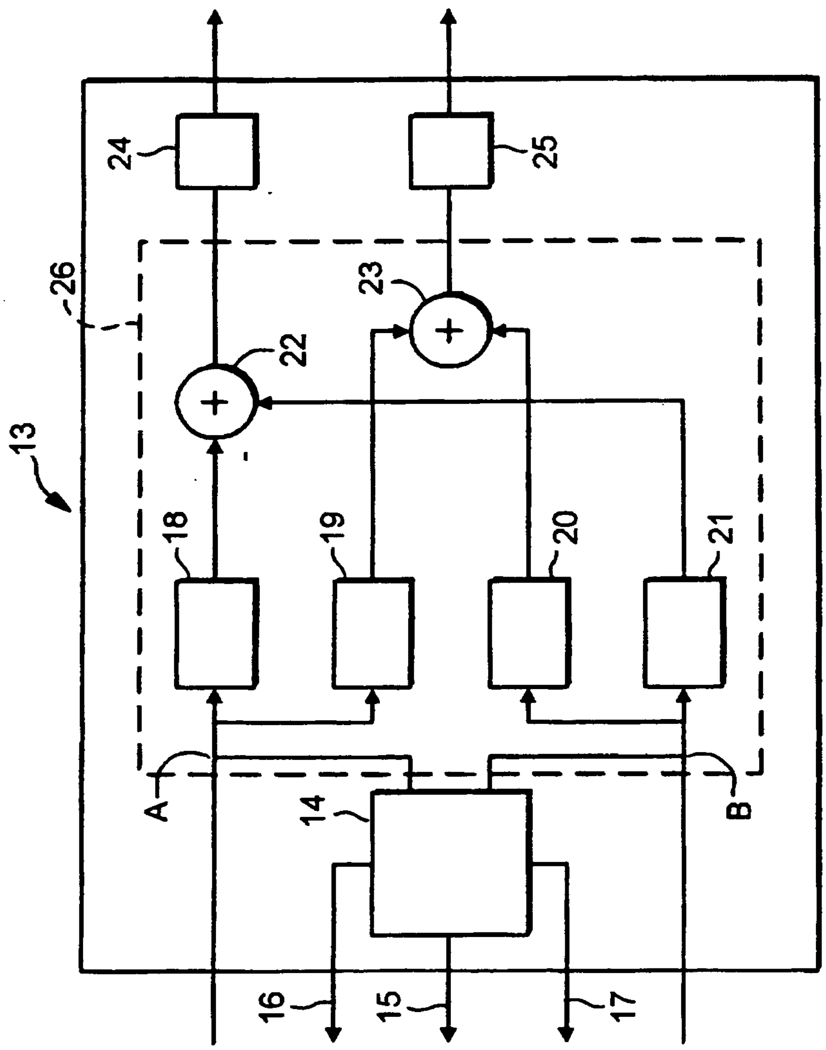

FIG. 3

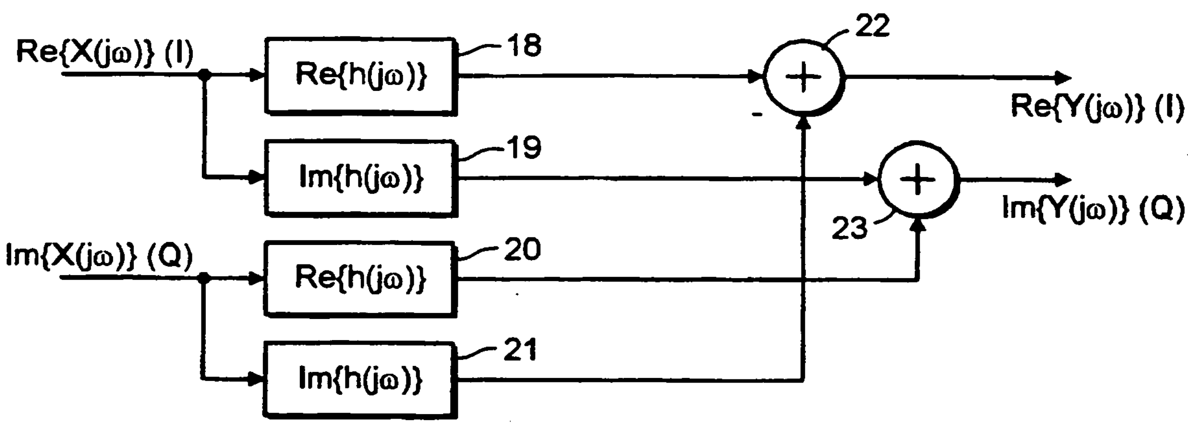
Re{X(jω)} (I)
Re{h(jω)}
18
22
Re{Y(jω)} (I)
-
Im{h(jω)}
19
Im{Y(jω)} (Q)
23
Im{X(jω)} (Q)
Re{h(jω)}
20
Im{h(jω)}
21

FIG. 4

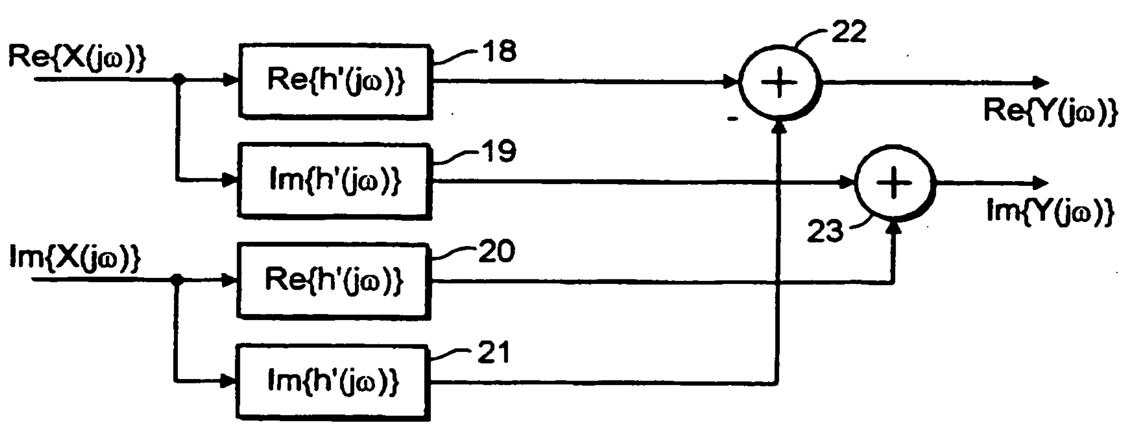
Re{X(jω)}
Re{h'(jω)}
18
22
Re{Y(jω)}
-
Im{h'(jω)}
19
Im{Y(jω)}
23
Im{X(jω)}
Re{h'(jω)}
20
Im{h'(jω)}
21

FIG. 5

RADIO RECEIVER AND A FILTER FOR THE RADIO RECEIVER

The present invention relates to a filter, in particular to an image rejection filter for a quadrature radio receiver, and a quadrature radio receiver incorporating such a filter.

The current trend in receiver technology is to reduce weight, volume, power consumption and cost. This is particularly important for receivers in portable apparatus such as radio telephones. This has resulted in receiver architecture designs in which there are no or few discrete radio frequency (RF) and intermediate frequency (IF) filters in the receiver front end.

One of the most common types of receiver is the superhetrodyne receiver in which the received RF signal is down-converted, using an oscillator, to an IF before conversion to baseband for demodulation. One consequence of down-converting the signal to an intermediate frequency is the production of an image signal. Such image signals are termed 'in-band' image signals. If a portion of the image signal is processed with the wanted signal cross talk can occur. As such it is desirable to reduce or reject cross talk.

One solution to this problem has been to provide band pass filters tuned to the desired RF frequency. However, single conversion low IF architectures for a quadrature radio receiver typically produce an image signal that is very close to the wanted signal. Suitable bandpass filters can not be integrated onto integrated circuits and are relatively expensive.

Another solution to this problem has been to use phase cancellation of the received analogue RF signal by using a double quadrature mixer architecture.

However, such an architecture requires 90° phase shifts on both the local oscillator and one of the RF ports coupled to a mixer. In this analogue configuration it is difficult to maintain phase and amplitude balance of the in-phase and quadrature signals which limits the achievable image rejection to typically 30 dB.

In accordance with one aspect of the present invention there is provided a quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the quadrature receiver having a digital image rejection filter comprising processor means arranged to impart to the quadrature and in-phase signal a substantially 90° shift to the negative frequencies and impart an substantially opposite 90° shift to the positive frequencies; and combining means for combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative intermediate frequency component is substantially cancelled.

An advantage of the digital image rejection filter is that it allows the filter to be integrated onto an integrated circuit. Further, as the frequency response of the filter is numerically defined the filter provides greater stability over a variety of temperatures and voltages.

In addition, the numerical precision of the processor means can be chosen to represent the full dynamic range of input signal thereby avoiding the introduction of any distortion or significant noise.

The received signal is down-converted to the intermediate frequency by mixing the received signal with a local oscillator. If the oscillator frequency is chosen to be below the wanted frequency the in-phase signal and the shifted quadrature signal are subtracted to provide the first output signal and the quadrature signal and the shifted in-phase signal are added to provide the second output signal.

Preferably the processing means has an impulse response which acts as a band-pass filter with a centre frequency at the positive or negative intermediate frequency.

This provides the advantage that further filtering is provided on the same IC.

The present invention is particularly suited for quadrature radio receivers having a low intermediate frequency. Typically the intermediate frequency will be less than 1 MHz, however preferably the low intermediate frequency is substantially half the input signal bandwidth.

Preferably the receiver further comprises sampling means arranged to under-sample the first and second output signals thereby converting the intermediate signal to a baseband signal.

This has the advantage that the signal is shifted in the frequency domain to form a baseband signal without introducing any distortion or significant noise.

In accordance with a second aspect of the present invention there is provided a digital image rejection filter for a quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency

component, the filter comprising processor means arranged to impart to the quadrature and in-phase signal a substantially 90° shift to the negative frequencies and impart a substantially opposite 90° shift to the positive frequencies; and combining means for combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative intermediate frequency component is substantially cancelled.

In accordance with a third aspect of the present invention there is provided a method of filtering a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the method comprising imparting to the quadrature and in-phase signal a substantially 90° shift to the negative frequencies and imparting an substantially opposite 90° shift to the positive frequencies; and combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative intermediate frequency component is substantially cancelled.

In accordance with a fourth aspect of the present invention there is provided a digital image rejection filter for a quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the filter comprising processor means having a filter impulse response

$$h(j\omega)e^{j\omega_{IF}t}$$

where h(jω) is the impulse response of a band-pass filter with a centre frequency at 0 Hz and $e^{j\omega IFt}$ imparts a convolution of the filter in the frequency domain to a centre frequency corresponding to the intermediate frequency such that the in-phase and quadrature signals are filtered by the real and complex components of the impulse response; and combining means for combining the in-phase signal filtered by the real component with the quadrature signal filtered by the complex component to provide a first output signal and combining the in-phase signal filtered by the complex component with the quadrature signal filtered by the real component to provide a second output signal.

For a better understanding of the present invention and to understand how the same may be brought into effect reference will now be made, by way of example only, to the accompanying drawings, in which:-

Figure 1 is a schematic diagram of a quadrature receiver in accordance with an embodiment of the present invention;

Figure 2a, 2b and 2c illustrates a typical frequency plan for a single conversion radio receiver;

Figure 3 shows a digital image rejection filter in accordance with an embodiment of the present invention;

Figure 4 illustrates a signal flow diagram of an image rejection filter in accordance with one embodiment of the present invention;

Figure 5 illustrates a signal flow diagram of an image rejection filter in accordance with a second embodiment of the present invention.

Figure 1 shows a schematic diagram for a quadrature single conversion receiver 1. A radio frequency signal x(t), typically being a quadrature modulated signal, is received by antenna 2. The received signal x(t) is filtered by the duplex filter 3 and then amplified by low noise amplifier 4. The amplified signal is input to mixers 5 and 6 by a power splitter (not shown). The local oscillator 7 outputs a signal LO which has a frequency close to the carrier frequency of the received signal x(t). The LO signal is fed directly into mixer 5 and is fed into mixer 6 via a –90° phase shifter 8. Preferably the phase shifter 8 is a voltage controlled phase shifter.

The local oscillator 7 is tuned, such that when the received signal x(t) and the LO signal are multiplied in mixers 5 and 6, each signal output from the mixers 5 and 6 has a centre frequency at a predetermined intermediate frequency. Consequently, the variable input frequency x(t) is down-converted to a fixed intermediate frequency ω_{IF}.

For a single conversion receiver suitable for a radio telephone the IF may be as low as half of the signal bandwidth. This would be around 20kHz for a radio telephone operating in an analogue radio telephone system such as Total Access Communication System (TACS), or around 100kHz for the Global System for Mobile communication (GSM) radio telephone system. The IF signal from mixer 5 is referred to as the 'real' or 'in-phase' I signal, and the IF signal from mixer 6 is termed the 'imaginary' or 'quadrature' Q signal.

Both the I and Q IF signals, hereinafter referred to as I and Q signals, comprise a wanted signal S and image signal IM.

Figures 2a, 2b and 2c show the frequency plan for the signal conversion receiver 1.

Figure 2a shows a LO signal with a wanted signal S $+\omega_{IF}$ Hz above the LO signal and an image signal IM $-\omega_{IF}$ Hz below the LO signal.

Figure 2b shows the complex spectrum of the IF signal output from mixer 5 (i.e. the in-phase signal I having been down-converted to an intermediate frequency). The wanted in-phase signal S is $+\omega_{IF}$ Hz above 0 Hz while the image in-phase signal IM is $-\omega_{IF}$ Hz below 0 Hz having the same phase as the wanted signal S.

Figure 2c shows the complex spectrum of the IF signal output from mixer 6 (i.e. the quadrature signal Q having been down converted to an intermediate frequency). The wanted quadrature signal S is $+\omega_{IF}$ Hz above 0 Hz while the image quadrature signal IM is $-\omega_{IF}$ Hz below 0 Hz having the opposite phase to the wanted signal S.

The image signal IM is known as cross talk and can interfere with the wanted signal S.

As shown in figure 1, the I and Q signals are input into gain amplifiers 9 and 10, which control the amplitude of the I and Q signals respectively. The I and Q signals are then passed to the analogue to digital convertors 11 and 12 respectively which convert the analogue I and Q signals into digital signals.

The digital I and Q signals are fed to a digital IF processor 13, typically a digital signal processor.

As shown in figure 3, the processor 13 provides a digital I/Q phase and gain balance correction system 14 which is coupled to the I and Q lines at points A and B respectively. The processor also provides an input 15 to the phase shifter 8 and inputs 16, 17 to the amplifiers 9 and 10 respectively. The phase and gain balance correction system 14 identifies any phase or gain imbalance between the I and Q signal and by means of the input 15 to the phase shifter 8 and the inputs 16, 17 to the amplifiers 9 and 10 makes necessary corrections to the phase and gain. An example of this system is described in detail in GB Patent No. 2 326 038 A and 2 326 037 A.

The processor 13 acts as a digital image rejection filter with a complex frequency response.

As shown in figure 3, the I and Q signals are fed to the image rejection filter 26 which comprises a finite impulse response (FIR) filter having real and imaginary components 18, 19, 20, 21, which are implemented in a processor, and combining means 22, 23. The I signal is fed to the real component 18 and an imaginary component 19 of the finite impulse response filter. The Q signal is fed to the real component 20 and imaginary component 21 of the finite impulse response filter. The output of filters 18 and 21 are combined using combining means 22 and the output of filters 19 and 20 are combined using combining means 23. Typically FIR 18 is the same as FIR 21 and FIR 19 is the same as FIR 20.

The signal flow diagram of one embodiment of the image rejection filter 26 is shown in figure 4. In this embodiment the impulse response $h(j\omega)$ of the imaginary component of the FIR filter acts to rotate negative frequencies by $-90°$ and rotate positive frequencies by $+90°$. A suitable transform to perform this function is the Hilbert transform. The filtering action of this transform acts to cancel the image, as shown below.

The filtering operation in the complex plane is

$$y(j\omega) = h(j\omega)x(j\omega)$$

where $y(j\omega)$ is the complex signal output, $x(j\omega)$ is the complex signal input and $h(j\omega)$ is the complex filter impulse response e.g. the Hilbert Transform. In its expanded complex form this equation can be rewritten as

$$y(j\omega) = [\mathrm{Re}\{h(j\omega)\} + j\mathrm{Im}\{h(j\omega)\}][\mathrm{Re}\{x(j\omega)\} + j\mathrm{Im}\{x(j\omega)\}]$$

where $\mathrm{Re}\{x(j\omega)\}$ equates to the I signal and $\mathrm{Im}\{x(j\omega)\}$ equates to the Q signal. Therefore the real component (i.e. $\mathrm{Re}\{y(j\omega)\}$ or I signal) of the filtered output signal is

$$\mathrm{Re}\{h(j\omega)\}\mathrm{Re}\{x(j\omega)\} - \mathrm{Im}\{h(j\omega)\}\mathrm{Im}x\{(j\omega)\}$$

and the imaginary component (i.e. $\mathrm{Im}\{y(j\omega)\}$ or Q signal) of the filtered output signal is

$$\mathrm{Im}\{h(j\omega)\}\mathrm{Re}\{x(j\omega)\} + \mathrm{Re}\{h(j\omega)\}\mathrm{Im}\{x(j\omega)\}$$

Therefore, dealing with the I signal, by subtracting

$$\mathrm{Im}\{h(j\omega)\}\mathrm{Im}x\{(j\omega)$$

from

$$\mathrm{Re}\{h(j\omega)\}\mathrm{Re}\{x(j\omega)\}$$

the image signal is cancelled from the I signal.

Correspondingly, dealing with the Q signal, by adding

$\mathrm{Im}\{h(j\omega)\}\mathrm{Re}\{x(j\omega)\}$

to

$\mathrm{Re}\{h(j\omega)\}\mathrm{Im}\{x(j\omega)\}]$

the image signal is cancelled from the Q signal.

Typically, the real component of the FIR acts as a delay to equalise the phase insertion of the Hilbert Transform.

Therefore, the image signal has been cancelled from both the I and Q signals while still maintaining the integrity of any quadrature modulation that may be present in the signal x(t).

The impulse response of this digital filter acts as a non-recursive filter (i.e. the output depends only on present and previous inputs). This is commonly known as a filter having a finite impulse response. This type of filter has the advantage that it is inherently stable. Further, this type of filter can be made symmetrical in form. This produces an ideal linear-phase characteristic resulting in no phase distortion.

The signal flow diagram of a second embodiment of the image rejection filter 26 is shown in figure 5. In this embodiment the image rejection filter incorporates a band pass filter. The impulse response of a digital band pass filter which has a centre frequency of 0 Hz (i.e. this represents a low pass

filter having a complex spectrum) is multiplied by a complex exponential in time to effect a shift in the frequency domain. The complex coefficients are chosen to provide a single sided band pass filter with a centre frequency at the chosen IF (i.e. ω_{IF}). This is represented as

$$h'(j\omega) = h(j\omega)e^{j\omega_{IF}t}$$

where $h'(j\omega)$ is the complex band pass filter impulse response with $h(j\omega)$ being the impulse response of the band pass filter with a centre frequency of 0 Hz and $e^{j\omega_{IF}t}$ is the complex exponential in time having a centre frequency at the chosen IF.

$e^{j\omega_{IF}t}$ can be written as

$\cos(\omega_{IF}t) + j\sin(\omega_{IF}t)$

therefore the real and imaginary components of the digital image rejection filter are

$\mathrm{Re}\{h'(j\omega)\} = h(j\omega)\cos(\omega_{IF}t)$

and

$\mathrm{Im}\{h'(j\omega)\} = h(j\omega)\sin(\omega_{IF}t)$

Accordingly the real component (i.e. $\mathrm{Re}\{y(j\omega)\}$ or I signal) of the filtered output signal is

$\mathrm{Re}\{h'(j\omega)\}\mathrm{Re}\{x(j\omega)\} - \mathrm{Im}\{h'(j\omega)\}\mathrm{Im}x\{(j\omega)\}$

and the imaginary component (i.e. $\mathrm{Im}\{y(j\omega)\}$ or Q signal) of the filtered output signal is

$$\mathrm{Im}\{h'(j\omega)\}\mathrm{Re}\{x(j\omega)\} + \mathrm{Re}\{h'(j\omega)\}\mathrm{Im}\{x(j\omega)\}$$

Therefore, dealing with the I signal, by subtracting

$$\mathrm{Im}\{h'(j\omega)\}\mathrm{Im}x\{(j\omega)$$

from

$$\mathrm{Re}\{h'(j\omega)\}\mathrm{Re}\{x(j\omega)\}$$

the filter only passes frequencies in the I signal within the bandwidth of the digital filter. Consequently the image signal is cancelled from the I signal.

Correspondingly, dealing with the Q signal, by adding

$$\mathrm{Im}\{h'(j\omega)\}\mathrm{Re}\{x(j\omega)\}$$

to

$$\mathrm{Re}\{h'(j\omega)\}\mathrm{Im}\{x(j\omega)\}]$$

the filter only passes frequencies in the Q signal within the bandwidth of the digital filter. Consequently the image signal is cancelled from the Q signal.

Preferably the filter blocks are convolutions in time with the input signal and the real/imaginary impulse response. However, the filter can be affected as

multiplies in the frequency domain where $X(j\omega)$ is the Fourier Transform of $x(t)$ and $H'(j\omega)$ is the Fourier Transform of the digital filter impulse response.

The filtered I and Q signals are then passed to A to D converters 24 and 25 respectively. The A to D converters 24, 25 sample the I and Q signals at the same rate as the I and Q signal bit rate. This has the effect of shifting the wanted IF I and Q signals to baseband. The I and Q signals are then fed to the demodulator/detector 26 which demodulates the modulated quadrature signal (e.g. QPSK). The demodulated signal is then passed to a D to A converter 27 before being passed to speaker 28.

The present invention may include any novel feature or combination of features disclosed herein either explicitly or implicitly or any generalisation thereof irrespective of whether or not it relates to the presently claimed invention or mitigates any or all of the problems addressed. In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. For example, it will be appreciated that oscillator frequencies greater than the wanted signal may be used, resulting in a positive image frequency.

CLAIMS

1. A quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the quadrature receiver having a digital image rejection filter comprising processor means arranged to impart to the quadrature and in-phase signal a substantially 90° shift to the negative frequencies and impart a substantially opposite 90° shift to the positive frequencies; and combining means for combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative intermediate frequency component is substantially cancelled.

2. A receiver according to claim 1, wherein the negative frequencies are shifted by substantially minus 90° and the positive frequencies are shifted by substantially plus 90°.

3. A receiver according to claim 1 or 2, wherein the in-phase signal and the shifted quadrature signal are subtracted to provide the first output signal and the quadrature signal and the shifted in-phase signal are added to provide the second output signal.

4. A receiver according to any of the preceding claims, wherein the processing means has an impulse response which acts as a band-pass filter with a centre frequency at the positive or negative intermediate frequency.

5. A receiver according to any of the preceding claims, wherein the intermediate frequency is a low intermediate frequency.

6. A receiver according to any of the preceding claims, wherein the intermediate frequency is substantially half the input signal bandwidth.

7. A receiver according to any of the preceding claims, further comprising sampling means arranged to under-sample the first and second output signals thereby converting the intermediate signal to a baseband signal.

8. A digital image rejection filter for a quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the filter comprising processor means arranged to impart to the quadrature and in-phase signal a substantially 90° shift to the negative frequencies and impart a substantially opposite 90° shift to the positive frequencies; and combining means for combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative intermediate frequency component is substantially cancelled.

9. A method of filtering a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the method comprising imparting to the quadrature and in-phase signal a substantially 90° shift to the negative

frequencies and imparting a substantially opposite 90° shift to the positive frequencies; and combining the in-phase signal with the shifted quadrature signal to provide a first output signal and combining the quadrature signal with the shifted in-phase signal to provide a second output signal such that the positive or negative intermediate frequency component is substantially cancelled.

10. A digital image rejection filter for a quadrature receiver arranged to generate from a received signal a digital intermediate frequency in-phase signal with a positive and negative frequency component and a digital intermediate frequency quadrature signal with a positive and negative frequency component, the filter comprising processor means having a filter impulse response

$$h(j\omega)e^{j\omega_{IF}t}$$

where h(jω) is the impulse response of a band-pass filter with a centre frequency at 0 Hz and $e^{j\omega IFt}$ imparts a convolution of the filter in the frequency domain to a centre frequency corresponding to the intermediate frequency such that the in-phase and quadrature signals are filtered by the real and complex components of the impulse response; and combining means for combining the in-phase signal filtered by the real component with the quadrature signal filtered by the complex component to provide a first output signal and combining the in-phase signal filtered by the complex component with the quadrature signal filtered by the real component to provide a second output signal.

11. A digital image rejection filter according to claim 10, wherein the filter is affected in the frequency domain.

12. A digital image rejection filter substantially as hereinbefore described with reference to the accompanying drawings.

13. A receiver substantially as hereinbefore described with reference to the accompanying drawings.

14. A method of filtering substantially as hereinbefore described with reference to the accompanying drawings.

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Application No: GB 9828542.2
Claims searched: 1-9

Examiner: Keith Williams
Date of search: 4 June 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4P (PAL, PAN, PAQ, PRE)

Int Cl (Ed.6): H03D 1/22, 7/16, 7/18; H04B 1/26, 1/30; H04L 27/233, 27/38

Other: Online EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2326038 A	Nokia Mobile Phones - see abstract	1,8,9
A	GB 2326037 A	Nokia Mobile Phones - see abstract	1,8,9
A	GB 2236225 A	Thorn EMI - see abstract	1,8,9
A	EP 0782249 A1	Lucent Technologies Inc. - see abstract	1,8,9
A	WO 91/03882 A1	AT&E Corp. - see abstract	1,8,9
A	US 5678220	France Telecom - see abstract (& EP 0687059)	1,8,9

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Application No: GB 9828542.2
Claims searched: 10 and 11

Examiner: Keith Williams
Date of search: 8 November 1999

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4P (PAL, PAN, PAQ, PRE)

Int Cl (Ed.6): H04L 27/233, 27/38; H04B 1/26, 1/30; H03D 1/22, 7/16, 7/18

Other: Online EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 5826180 Nice Systems - see abstract	10,11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.